RMS CONVERTERS: OPTION 31 FOR 4800 DVM & OPTION 32 FOR 5900 DMM

1.0 GENERAL.

1.1 The Dana RMS Converters (Options 31 and 32) are used in the Dana Series 4800 and 5900 DVM's respectively. The converters consist of a single printed circuit board and mount in connector J11 of the appropriate DVM. A bypass board is required for each instrument to adapt the converter to the instrument. The converter and bypass board for each instrument is indicated in table 1. Unless otherwise specified, the description covers both Option 31 and Option 32.

Table 1 - Assembly Location

Board Location	4800	5900
J11 Bypass	403806	403807
J12 Converter	403773	403774

2.0 DESCRIPTION.

2.1 The Dana True RMS Converter provides a d.c. output voltage proportional to the RMS (Root Mean Square) value of the input signal. The converter can handle signals with crest factors of 7 to 1. The use of log transistors, instead of a thermopile, results in fast settling time and wide dynamic range.

2.2 Timeouts.

2.3 The timeout signal generated by the converter is dependent on the instrument in which it is used and whether or not the filter is selected as shown in table 2.

Table 2 - RMS Converter Timeouts

	4800	5900
Auto range w/filter	585 ms	570 ms
Fixed range no filter	365 ms	100 ms

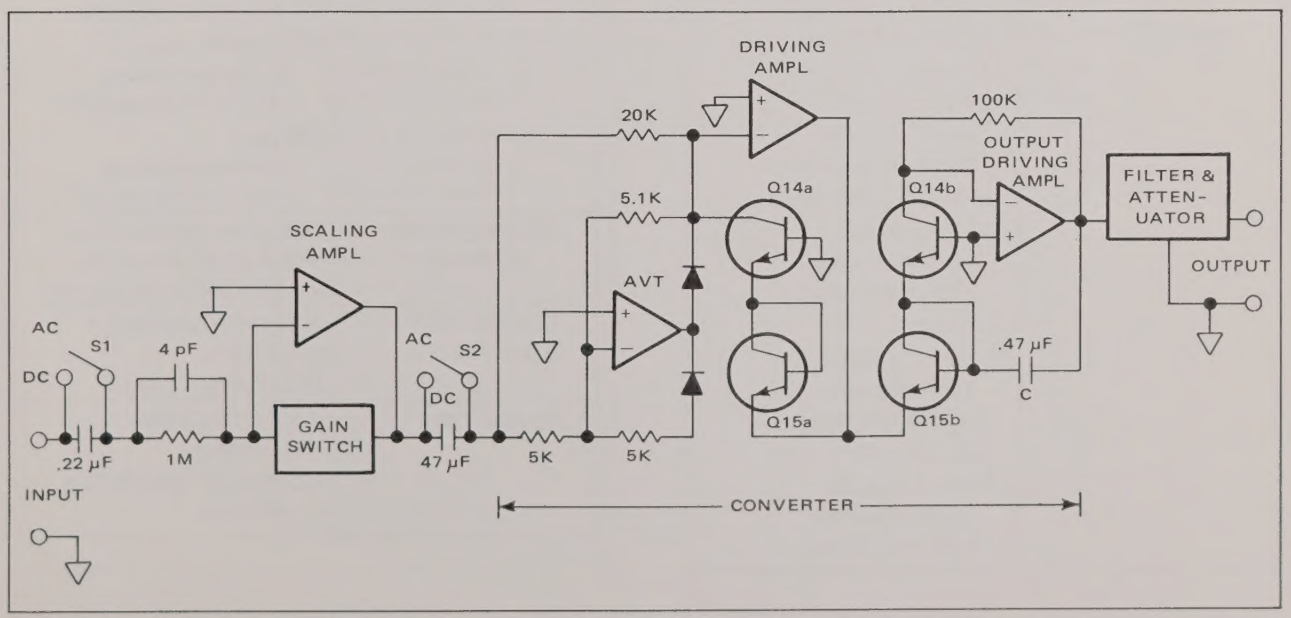


Figure 1 - RMS AC Converter

2.4 Specifications.

Specifications

4800 – Model 31

AC VOLTS TRUE RMS	
Ranges:	.10000V, 1.0000V, 10.000V, 100.00V, 1000.0V RMS
Resolution:	0.01% of range 10 μV on .1V range
Overrange:	100%, (within maximum input voltage limit)
Maximum Input Voltage:	1000V DC/RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. $2x10^7$ VHz maximum on any range
Maximum Crest Factor: **(Pulses at 1 kHz Repetition Rate)**	7:1 at full-scale 22:1 at 10% of full-scale
Accuracy: AC mode	90 days, 23°C ± 5°C 20 Hz – 30 Hz ±(.6% of reading +.03% of full scale) 30 Hz – 50 Hz ±(.3% of reading +.03% of full scale) 50 Hz – 100 Hz ±(.1% of reading +.03% of full scale) 1, 10, 100, 1000V range 100 Hz – 20 kHz ±(.07% of reading +.03% of full scale) .1V range 100 Hz – 20 kHz ±(.1% of reading +.03% of full scale) 1, 10, 100, 1000V range 20 kHz – 50 kHz ±(.1% of reading +.1% of full scale) .1V range 20 kHz – 100 kHz ±(1% of reading +.2% of full scale) 1, 10, 100, 1000V range 50 kHz – 100 kHz ±(.2% of reading +.2% of full scale)

Accuracy: *(con't)* AC Mode *(con't)*	10, 100, 1000V range 100 kHz – 300 kHz ±(3% of reading +.5% of full scale) 1V range 100 kHz – 300 kHz ±(5% of reading +1% of full scale) 300 kHz – 1 MHz Add [10 f (MHz) % of reading +.5% of full scale to 300 kHz spec]
AC & DC Mode	Add .02% of full scale to AC specification
For inputs >500V multiply % of reading spec by $(1 + \frac{Vin}{2000})$	
1 Hz operation available on special request	
Temperature Coefficient:	0°C to 50°C AC coupled (to 20 kHz) 1V – 1000V range ±(.004% of reading +.003% of full scale)/°C .1V range ±(.006% of reading +.003% of full scale)/°C DC coupled (to 20 kHz) 1V – 1000V range ±(.004% of reading +.005% of full scale)/°C .1V range ±(.006% of reading +.005% of full scale)/°C
Input Impedances: AC Mode	1 Megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common
Common Mode Rejection:	With 100Ω unbalance in either lead DC to 60 Hz: 120 dB
Settling Time:	0 to Full Scale Step 300 msec Full Scale to 10% FS Step 400 msec

AC VOLTS TRUE RMS	
Ranges:	1.00000V, 10.0000V, 100.000V, 1000.00V RMS
Resolution:	0.001% of range 10 μV on 1V range
Overrange:	60%, (within maximum input voltage limit)
Maximum Input Voltage:	1000V DC/RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. $2x10^7$ VHz maximum on any range
Maximum Crest Factor: **(Pulses at 1 kHz Repetition Rate)**	7:1 at full-scale 22:1 at 10% of full-scale
Accuracy: AC Mode	90 days, 23°C ± 5°C 20 Hz – 30 Hz (filtered) ±(.5% of reading +.03% of full scale) 30 Hz – 50 Hz (filtered) ±(.2% of reading +.03% of full scale) 50 Hz to 100 Hz (filtered) ±(.1% of reading +.03% of full scale) 100 Hz – 20 kHz (filtered) ±(.07% of reading +.03% of full scale) 200 Hz to 20 kHz (no filter) ±(.07% of reading +.03% of full scale) 20 kHz – 50 kHz (both) ±(.1% of reading +.1% of full scale) 50 kHz – 100 kHz (both) ±(.2% of reading +.2% of full scale) 10, 100, 1000V range 100 kHz – 300 kHz ±(3% of reading +.5% of full scale) 1V range 100 kHz – 300 kHz ±(5% of reading +1% of full scale)

Accuracy: *(con't)* AC Mode *(con't)*	300 kHz – 1 MHz Add [10 f (MHz) % of reading +.5% of full scale to 300 kHz specification]
AC & DC Mode	Add ±.02% of full scale to AC specification
For inputs greater than 500V multiply % of reading spec by $(1 + \frac{Vin}{2000})$	
1 Hz operation available on special request	
Temperature Coefficient:	0°C to 50°C AC Mode (to 20 kHz) ±(.004% of reading +.003% of full scale)/°C AC & DC Mode (to 20 kHz) ±(.004% of reading +.005% of full scale)/°C
Input Impedances: AC Mode	1 Megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common
Common Mode Rejection:	With 100Ω unbalance in either lead DC to 60 Hz: 120 dB
Settling Time:	(to within .1% of range) 0 to Full Scale Step Filter Out 80 msec Filter In 350 msec Full Scale to 10% FS Step Filter Out 100 msec Filter In 400 msec

3.0 OPERATION.

3.1 A simplified schematic of the RMS Converter is shown in figure 1. S1 and S2 are two-position AC/DC switches located on the circuit board. In AC position, only the AC portion of the signal is measured; in DC, the total signal, ac + dc, is measured. Range switching in the feedback circuit of the Scaling Amplifier scales the signal to 1.0V RMS, full-scale, at the Scaling Amplifier output.

3.2 The Scaling Amplifier drives an AVT (Absolute Value Taker) circuit which performs full-wave rectification of the signal. It also converts the signal voltage to a current. One volt into the AVT produces a 50 μamp current into the summing junction of the Driving Amplifier.

3.3 Transistors Q14a, Q14b, Q15a, and Q15b are matched transistors connected as diodes. Q15b squares the signal, capacitor C averages it, and Q14b extracts the square root. The Output Driving Amplifier produces a dc output of 0 to 5 volts (full-scale) with some ac ripple superimposed. It is the ripple voltage that drives capacitor C.

3.4 The d-c output is delivered through a filter/attenuator circuit that removes the a-c ripple and scales the signal voltage to 1.0V, full-scale.

4.0 CALIBRATION (Figure 2).

4.1 The instrument in which the RMS option is housed must be calibrated before the RMS option is calibrated. The RMS option should be calibrated in the instrument in which it is to operate to insure full accuracy. Equipment required for the calibration of the RMS Converter is listed in table 3. The sequence of calibration is designed to minimize interaction of controls and should not be deviated from. Apply power and allow at least 10 minutes for the board to temperature stabilize.

a. Allow machine to warm up for at least 10 minutes. Set instrument to 1V AC range; select FILTER. Set S1 and S2, on RMS Converter, to "DC" (away from center of board). Turn R42 fully counter-clockwise. See table 3 for required equipment.

b. Short input terminals. Connect the microvoltmeter to TP1 (+) and TP5 (–). Adjust R17 for microvoltmeter reading of zero volts.

c. Short TP2 to TP5. Connect microvoltmeter from TP3 (+) to TP5. Adjust R33 for microvoltmeter reading of zero volts. This zeros the AVT offset voltage.

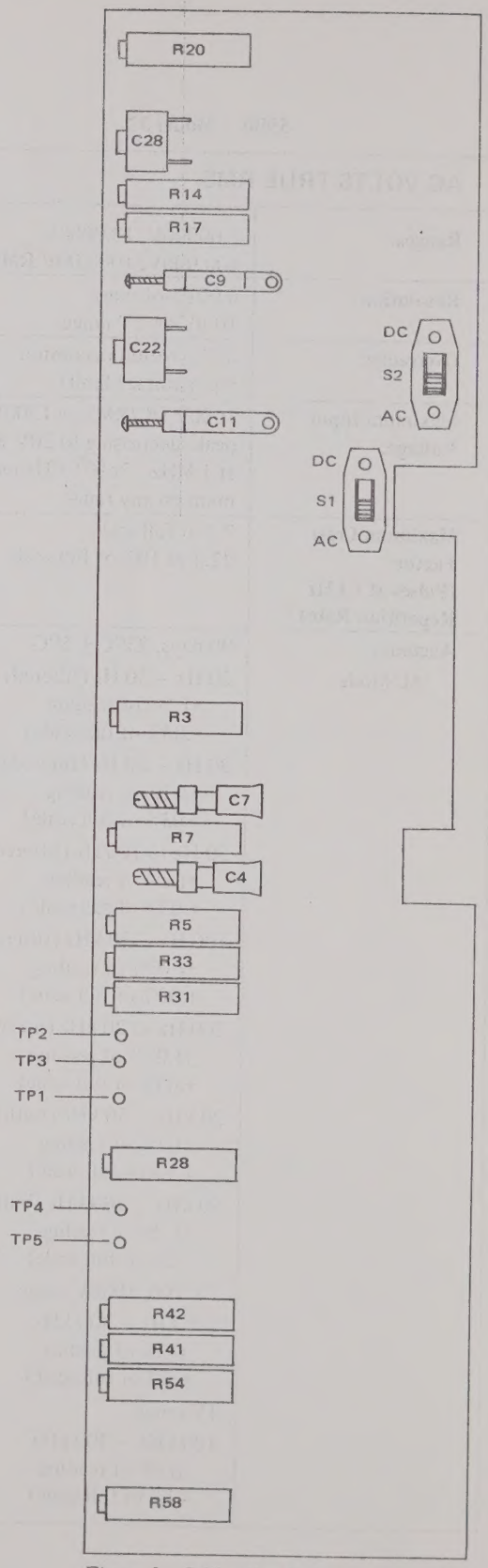


Figure 2 - Calibration Points

Table 3 - Equipment Required

Name	Recommended Type
DC Voltage Standard	Fluke 332A (or equivalent)
AC Lab Power Source	HP745/746 (or equivalent)
Microvoltmeter	Fluke 845A (or equivalent)

d. Remove short from TP2-TP5. Short TP4 to TP5. Connect microvoltmeter from TP3 (+) to TP5 (–). Adjust R31 for a microvoltmeter reading of zero volts. This zeros the AVT bias current. Remove meter leads.

e. With TP4 still shorted to ground (TP5), adjust the AC OFFSET control on front panel for a readout of all zeros on the DVM display. This adjusts the Driving Amplifier offset voltage.

f. Adjust R42 for a positive DVM display of greater than zero but less than .02% of full-scale. This zeros the Driving Amp offset voltage.

g. Remove the short from TP4 to ground. Adjust R41 to obtain the same reading obtained in step f. This zeros the Driving Amp bias current.

h. Remove short from input terminals. Apply –1.000 VDC to DVM input. Note value of DVM display.

i. Reverse polarity of input to +1.000 VDC. Adjust R28 to obtain approximately the same DVM display as obtained in step h. Repeat steps h and i until the two readings are within .01% of each other. This adjusts the AVT for equal gain with inputs of either polarity.

j. If a pulse generator is available, apply a 1.000V RMS pulse train with a crest factor of 7 and a period of 1 msec (1 kHz repetition rate). Adjust R54 for a readout of 1.000V.

k. Switch S1 and S2 to "AC" position (toward center of board); set range to 1. Apply +1.000V at 500 Hz. Adjust R58 for a display of +1.0000. Decrease input to +.1000V at 500 Hz. Adjust AC OFFSET on front panel for a readout of +.1000V. Repeat both of these adjustments until the exact readout is obtained for each.

l. Apply inputs listed below and adjust the indicated control for the proper readout.*

Range	INPUT		Adjust	Readout	Function
	AC Voltage	Freq.			
1000	1000.0	500 Hz	R3	1000.0	1 KV low freq gain
1000	1000.0	50 kHz	C11*	1000.0	1 KV high freq gain
1.0	1.0000	50 kHz	C9*	1.0000	1V high freq gain
10	10.000	500 Hz	R7	10.000	10V low freq gain
10	10.000	50 kHz	C7*	10.000	10V high freq gain
100	100.00	500 Hz	R5	100.00	100V low freq gain
100	100.00	50 kHz	C4*	100.00	100V high freq gain
1000	1000.	50 kHz	C22*	1000.	1 KV high freq gain

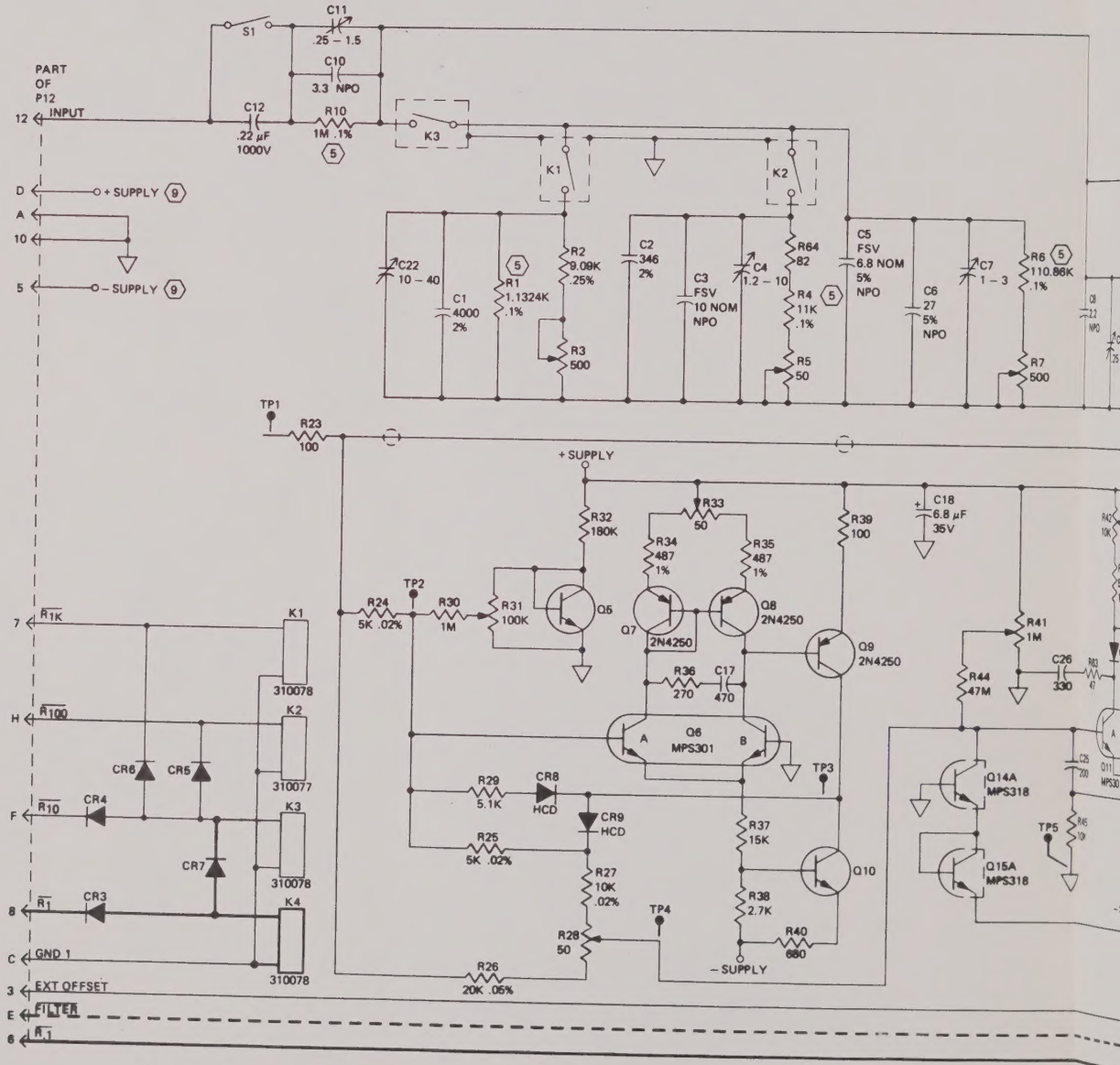
*Use an insulated screwdriver when adjusting the capacitors. High voltage is present on C11.

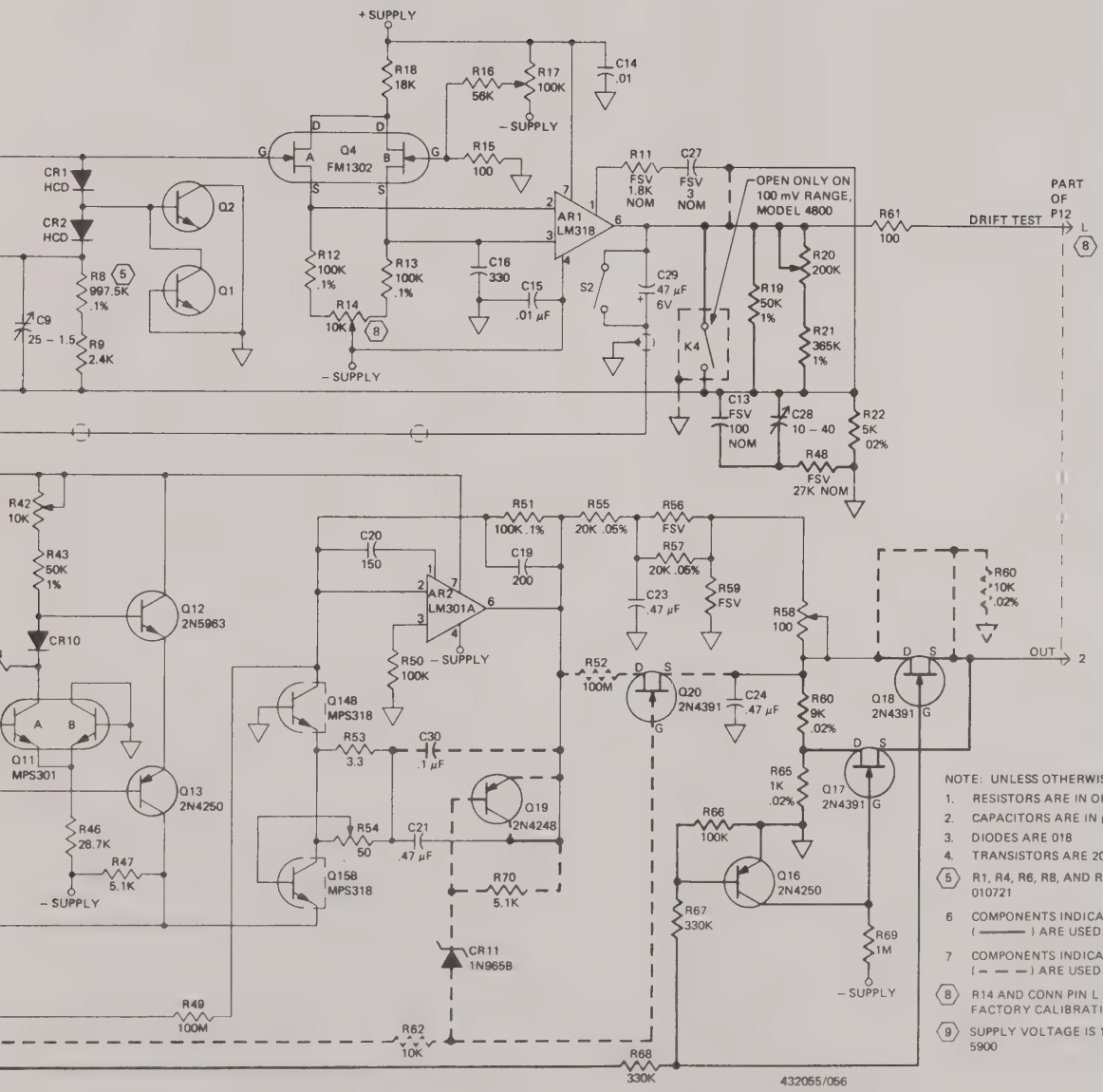
m. For Model 4800 only: continue with the following adjustments:

Range	INPUT		Adjust	Readout	Function
	AC Voltage	Freq.			
100 mV	.1000	500 Hz	R20	100.0	100 mV low freq gain
100 mV	.1000	20 kHz	C28	100.0	100 mV high freq gain

403773 (4800)

403774 (5900)


PART OF P12
12 INPUT
S1
C11 .25 – 1.5
C10 3.3 NPO
C12 .22 μF 1000V
R10 1M .1%
5
K3
K1
K2
D + SUPPLY 9
A
10
5 – SUPPLY 9
C22 10 – 40
C1 4000 2%
5
R1 1.1324K .1%
R2 9.09K .25%
R3 500
C2 346 2%
C3 FSV 10 NOM NPO
C4 1.2 – 10
R64 82
R4 11K .1%
R5 50
C5 FSV 6.8 NOM 5% NPO
C6 27 5% NPO
C7 1 – 3
R6 110.86K .1%
R7 500
TP1
R23 100
+ SUPPLY
R32 180K
R33 50
R34 487 1%
R35 487 1%
R39 100
C18 6.8 μF 35V
TP2
R24 5K .02%
R30 1M
R31 100K
Q5
Q7 2N4250
Q8 2N4250
Q9 2N4250
R36 270
C17 470
Q6 MPS301
A
B
R41 1M
R44 47M
C26 330
Q14A MPS318
Q15A MPS318
TP5
TP3
R29 5.1K
CR8 HCD
CR9 HCD
R25 5K .02%
R27 10K .02%
R28 50
TP4
R37 15K
R38 2.7K
R40 680
Q10
– SUPPLY
R26 20K .05%
7 R1K
H R100
F R10
8 R1
C GND 1
3 EXT OFFSET
E FILTER
6 R.1
K1 310078
K2 310077
K3 310078
K4 310078
CR6
CR5
CR4
CR7
CR3


+ SUPPLY
R18 18K
R16 56K
R17 100K
C14 .01
- SUPPLY
Q4 FM1302
R15 100
CR1 HCD
CR2 HCD
Q2
Q1
R8 997.5K .1%
C9 25 - 1.5
R9 2.4K
R12 100K .1%
R13 100K .1%
R14 10K
C16 330
C15 .01 μF
AR1 LM318
R11 FSV 1.8K NOM
C27 FSV 3 NOM
OPEN ONLY ON 100 mV RANGE, MODEL 4800
R61 100
DRIFT TEST
PART OF P12
S2
C29 47 μF 6V
K4
R19 50K 1%
R20 200K
R21 365K 1%
C13 FSV 100 NOM
C28 10 - 40
R22 5K .02%
R48 FSV 27K NOM
R42 10K
R43 50K 1%
Q12 2N5963
CR10
Q11 MPS301
R46 28.7K
R47 5.1K
C20 150
C19 200
AR2 LM301A
R50 100K
R51 100K .1%
R55 20K .05%
R56 FSV
R57 20K .05%
C23 .47 μF
R59 FSV
R58 100
R60 10K .02%
OUT
R52 100M
Q20 2N4391
C24 .47 μF
R60 9K .02%
Q18 2N4391
Q148 MPS318
R53 3.3
C30 .1 μF
Q19 12N4248
R54 50
C21 .47 μF
Q158 MPS318
R70 5.1K
R65 1K .02%
Q17 2N4391
R66 100K
Q16 2N4250
R67 330K
R69 1M
CR11 1N965B
R49 100M
R62 10K
R68 330K
NOTE: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
2. CAPACITORS ARE IN pF
3. DIODES ARE 018
4. TRANSISTORS ARE 200200
5 R1, R4, R6, R8, AND R10 ARE RESISTOR SET 010721
6 COMPONENTS INDICATED BY BOLD LINE (———) ARE USED ON MODEL 4800 ONLY
7 COMPONENTS INDICATED BY DASHED LINE (- — -) ARE USED ON MODEL 5900 ONLY
8 R14 AND CONN PIN L USED ONLY FOR FACTORY CALIBRATION
9 SUPPLY VOLTAGE IS 18V FOR 4800, 20V FOR 5900
432055/056

403773/774 – Assy., PCB, RMS AC CONVERTER

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	130116	CAP	MICA	4000 PFD	500 V	2%	72136	DM19
C2	130115	CAP	MICA	346 PFD	500 V	2%	72136	DM15
C3	100075	CAP	CERAM	10 PFD	1 KV		56289	10TCCQ10
C4	130124	CAP	TRIMMER	1.2-10 PFD	250 V			R-TRIKO-122-09SD
C5	100085	CAP	CERAM	6.8 PFD	1 KV		56289	10TCCV68
C6	100054	CAP	CERAM	27 PFD	1 KV	5%	56289	10TCCQ27
C7	130123	CAP	TRIMMER	1-3 PFD	250 V			R-TRIKO-122-09SD
C8	100050	CAP	CERAM	2.2 PFD	1 KV	5%	56289	10TCCV22
C9	130146	CAP	TRIMMER	.25-1.5 PFD			74970	273-0001-002
C10	100072	CAP	CERAM	3.3 PFD	1 KV	10%	56289	10TCCV33
C11	130146	CAP	TRIMMER	.25-1.5 PFD			74970	273-0001-002
C12	120280	CAP	MYLAR	.22 MFD	1000 V		27556	ZA2J224K
C13*	130066	CAP	MICA	100 PFD	500 V	5%	09023	C015FD101J03
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	101098	CAP	CERAM	330 PFD	500 V	10%	71471	SCD1X5F
C17	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
C18	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C19	130076	CAP	MICA	200 PFD	500 V	5%	72136	DM15-201J
C20	101642	CAP	CERAM	150 PFD	500 V	10%	71471	SCD2X5F
C21	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C22	130127	CAP	TRIMMER	10-40 PFD				10S-TRIKO-24N750
C23	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C24	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C25	101644	CAP	CERAM	200 PFD	1000 V	20%		
C26	101098	CAP	CERAM	330 PFD	500 V	10%	71471	SCD1X5F
C27	100051	CAP	CERAM	3.0 PFD	1 KV		71471	TCD-D1-0
C28*	130127	CAP	TRIMMER	10-40 PFD				10S-TRIKO-24N750
C29	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C30**	120286	CAP	MYLAR	.1 MFD	100 V	20%	73445	C281AH/A100K
CR1	210035	DIODE			5082-2810		50434	5082-2810
CR2	210035	DIODE			5082-2810		50434	5082-2810
CR3*	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7*	211083	DIODE	SILICO		018		21793	211083

*Used in Model 4800 only
**Used in Model 5900 only

403773/774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
CR8	210035	DIODE			5082-2810		50434	5082-2810
CR9	210035	DIODE			5082-2810		50434	5082-2810
CR10	211083	DIODE	SILICO		018		21793	211083
CR11**	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
K1	310078	REED	RELAY SHIELD		28 V		15636	R2690-3
K2	310078	REED	RELAY SHIELD		28 V		15636	R2690-3
K3	310078	REED	RELAY SHIELD		28 V		15636	R2690-3
K4*	310078	REED	RELAY SHIELD		28 V		15636	R2690-3
Q1	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q2	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q4	200199	TRANS	FET		FM1302		27014	FM1302
Q5	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q6	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q7	200068	TRANS			2N4250		80131	2N4250
Q8	200068	TRANS			2N4250		80131	2N4250
Q9	200068	TRANS			2N4250		80131	2N4250
Q10	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q11	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q12	200136	TRANS			2N5963		81349	2N5963
Q13	200068	TRANS			2N4250		80131	2N4250
Q14	200213	TRANS	DUAL		MPS318			MPS318
Q15	200213	TRANS	DUAL		MPS318			MPS318
Q16*	200068	TRANS			2N4250		80131	2N4250
Q17*	200179	TRANS	FET		2N4391		81349	2N4391
Q18*	200179	TRANS	FET		2N4391		81349	2N4391
Q19**	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q20**	200179	TRANS	FET		2N4391		81349	2N4391
AR1	230180	INTEGRATED CIRCUIT			LM318H		27014	LM318H
AR2	230054	INTEGRATED CIRCUIT			LM301A		27014	LM301A
R1	010721	RES	METAL	MATCHED SET			81349	RN75
R2	010720	RES	METAL	9.09 K	T-2	.25%	81349	RN55C
R3	040228	POT	CERMET	500 OHM		10%	73138	89P
R4	010721	RES	METAL	MATCHED SET			81349	RN75
R5	040225	POT	CERMET	50 OHM		20%	73138	89P

*Used in Model 4800 only
**Used in Model 5900 only

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R6	010721	RES	METAL	MATCHED SET			81349	RN75
R7	040228	POT	CERMET	500 OHM		10%	73138	89P
R8	010721	RES	METAL	MATCHED SET			81349	RN75
R9	000242	RES	CARBON	2.4 K		5% 1/4W	81349	RC07GF242J
R10	010721	RES	METAL	MATCHED SET			81349	RN75
R11	000182	RES	CARBON	1.8 K		5% 1/4W	81349	RC07GF182J
R12	010542	RES	METAL	100 K		1%	81349	RN55E
R13	010542	RES	METAL	100 K		1%	81349	RN55E
R14	040232	POT		10 K	89P	10%	73138	89P
R15	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R16	000563	RES	CARBON	56 K		5% 1/4W	81349	RC07GF563J
R17	040235	POT	CERMET	100 K		10%	73138	89P
R18	000183	RES	CARBON	18 K		5% 1/4W	81349	RC07GF183J
R19*	010670	RES	METAL	50 K		1%	81349	RN55E
R20*	040236	POT	CERMET	200 K		10%	73138	89P
R21*	010257	RES	METAL	365 K	T-2	1%	81349	RN60C3653F
R22*	010586	RES	METAL	5 K		.02%	18612	V53-1M
R23	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R24	010586	RES	METAL	5 K		.02%	18612	V53-1M
R25	010586	RES	METAL	5 K		.02%	18612	V53-1M
R26	010654	RES	METAL	20 K		.05%	18612	V53-1
R27	010615	RES	METAL	10 K		.02%	18612	V53-1M
R28	040225	POT	CERMET	50 OHM		20%	73138	89P
R29	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R30	000105	RES	CARBON	1 M		5% 1/4W	81349	RC07GF105J
R31	040235	POT	CERMET	100 K		10%	73138	89P
R32	000184	RES	CARBON	180 K		5% 1/4W	81349	RC07GF184J
R33	040225	POT	CERMET	50 OHM		20%	73138	89P
R34	010684	RES	METAL	487 OHM	T-9	1%	81349	RN55E4870F
R35	010684	RES	METAL	487 OHM	T-9	1%	81349	RN55E4870F
R36	000271	RES	CARBON	270 OHM		5% 1/4W	81349	RC07GF271J
R37	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R38	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R39	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R40	000681	RES	CARBON	680 OHM		5% 1/4W	81349	RC07GF681J
R41	040239	POT	CERMET	1 M		20%	73138	89P
R42	040232	POT		10 K	89P		73138	89P
R43	010670	RES	METAL	50 K		1%	81349	RN55E
R44	000476	RES	CARBON	47 M		5% 1/4W	81349	RC07GF476J
R45	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J

*Used in Model 4800 only

403773/774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
R46	010533	RES	METAL	28.7 K	1%	81349	RN55D
R47	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R48*	000273	RES	CARBON	27 K	5% 1/4W	81349	RC07GF273J
R49	000107	RES	CARBON	100 M	5% 1/4W	81349	RC07GF107J
R50	000104	RES	CARBON	100 K	5% 1/4W	81349	RC07GF104J
R51	020667	RES	WW	100 K	.1%	22045	J-110
R52**	000107	RES	CARBON	100 M	5% 1/4W	81349	RC07GF107J
R53	001768	RES	CARBON	3.3 OHM	5% 1/4W		
R54	040225	POT	CERMET	50 OHM	20%	73138	89P
R55	010654	RES	METAL	20 K	.05%	18612	V53-1
R56	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R57	010654	RES	METAL	20 K	.05%	18612	V53-1
R58	040226	POT	CERMET	100 OHM	10%	73138	89P
R59	001737	RES	CARBON	FSV	5% 1/4W	21793	001737
R60*	010614	RES	METAL	9 K	.02%	18612	V53-1
R60**	010615	RES	METAL	10 K	.02%	18612	V53-1M
R61	000101	RES	CARBON	100 OHM	5% 1/4W	81349	RC07GF101J
R62**	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R63	000470	RES	CARBON	47 OHM	5% 1/4W	81349	RC07GF470J
R64	000820	RES	CARBON	82 OHM	5% 1/4W	81349	RC07GF820J
R65*	010613	RES	METAL	1 K	.02%	18612	V53-1
R66*	000104	RES	CARBON	100 K	5% 1/4W	81349	RC07GF104J
R67*	000334	RES	CARBON	330 K	5% 1/4W	81349	RC07GF334J
R68*	000334	RES	CARBON	330 K	5% 1/4W	81349	RC07GF334J
R69*	000105	RES	CARBON	1 M	5% 1/4W	81349	RC07GF105J
R70**	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
S1	600742	SWITCH	SLIDE	G-111		79727	G-111
S2	600742	SWITCH	SLIDE	G-111		79727	G-111
TP1	600591	POST	TEST POINT	85931-6		89110	85931-6
TP2	600591	POST	TEST POINT	85931-6		89110	85931-6
TP3	600591	POST	TEST POINT	85931-6		89110	85931-6
TP4	600591	POST	TEST POINT	85931-6		89110	85931-6
TP5	600591	POST	TEST POINT	85931-6		89110	85931-6

*Used in Model 4800 only
**Used in Model 5900 only

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